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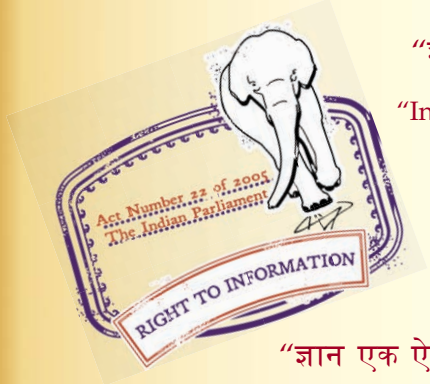
IS 1248-1 (2003): Direct Acting Indicating Analogue Electrical Measuring Instruments and their Accessories - Part : 1 General Requirements [ETD 12: Measuring Equipment for Basic Electrical Quantities]



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"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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भारतीय मानक

प्रत्यक्ष क्रियाशील सूचक अनुरूप वैद्युत मापन उपकरण तथा उनके सहायक उपकरण

भाग 1 परिभाषाएँ तथा सामान्य अपेक्षाएँ

(चौथा पुनरीक्षण)

Indian Standard

DIRECT ACTING INDICATING ANALOGUE ELECTRICAL MEASURING INSTRUMENTS AND THEIR ACCESSORIES

PART 1 DEFINITIONS AND GENERAL REQUIREMENTS

(Fourth Revision)

ICS 17.220.20

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

September 2003

Price Group 10

AMENDMENT NO. 1 OCTOBER 2007
TO
IS 1248 (PART 1) : 2003 DIRECT ACTING INDICATING ANALOGUE ELECTRICAL MEASURING INSTRUMENTS AND THEIR ACCESSORIES

PART 1 DEFINITIONS AND GENERAL REQUIREMENTS

(Fourth Revision)

(*Page* 8, *Table* 2, *col* 4) — Substitute '5.2', '5.3', '5.6', '5.7', '5.8', '5.4', '5.5', '5.14', '5.17', '5.18' *for* '3.2', '3.3', '3.6', '3.7', '3.8', '3.4', '3.5', '3.14', '3.17', '3.18' respectively.

(*Page* 9, *clause* **6.2.3**, *second para*) — Substitute '**5.1**' *for* '**3.1**'.

(*Page* 9, *clause* **6.2.4**, *first para*) — Substitute '**5.13**' *for* '**3.13**'.

(*Page* 10, *clause* **7.2.1**, *first para*) — Substitute '**6.2**' *for* '**4.2**'.

(*Page* 10, *clause* **7.2.2**, *second para*) — Substitute '**6.3**' *for* '**4.3**'.

(*Page* 10, *clause* **7.3**, *first para*) — Substitute '**6.14**' *for* '**4.14**'.

(*Page* 10, *clause* **7.5**, *first para*) — Substitute '**6.1**' *for* '**4.1**'.

(*Page* 11, *Figure* 1, *captions*) — Substitute 'A' *for* 'V'.

(*Page* 11, *Figure* 2, *captions*) — Substitute 'V' *for* 'A'.

(*Pages* 20, 21 *and* 22, *Annex* A) — Substitute Annex A given on pages 2 and 3 of this Amendment for the existing.

(*Page* 25, *Annex* C, *Sl No.* 1, *col* 2) — Substitute '5 1' *for* '1 to 8'.

(*Page* 25, *Annex* C, *Sl No.*1, *col* 3) — Substitute '3.1' *for* '1.2.1'.

(*Page* 25, *Annex* C, *Sl No.* 2, *col* 3) — Substitute '3.2' *for* '1.2.2'.

(*Page* 25, *Annex* C, *Sl No.* 3, *col* 3) — Substitute '3.3' *for* '1.2.3'.

(*Page* 25, *Annex* C, *Sl No.* 4, *col* 2) — Substitute '6.3.1' *for* '6.3.2'.

(*Page* 25, *Annex* C, *Sl No.* 4, *col* 3) — Substitute '3.4' *for* '1.2.4'.

(*Page* 25, *Annex* C, *Sl No.* 5, *col* 3) — Substitute '3.5' *for* '1.2.5'.

(*Page* 25, *Annex* C, *Sl No.* 6, *col* 3) — Substitute '3.8' *for* '1.2.8'.

(*Page* 25, *Annex* C, *Sl No.* 7, *col* 3) — Substitute '3.9' *for* '1.2.9'.

(*Page* 25, *Annex* C, *Sl No.* 8, *col* 3) — Substitute '3.10' *for* '1.2.10'.

(*Page* 25, *Annex* C, *Sl No* 9, *col* 3) — Substitute '3.11' *for* '1.2.11'.

(*Page* 25, *Annex* C, *Sl No* 10, *col* 3) — Substitute '3.12' *for* '1.2.12'.

(*Page* 25, *Annex* C, *Sl No* 11, *col* 3) — Substitute '3 13' *for* '1.2.13'

(*Page* 25, *Annex* C, *Sl No.* 12, *col* 2) — Substitute '11' *for* '4.4'.

(*Page* 25, *Annex* C, *Sl No* 12, *col* 3) — Substitute '3.14' *for* '1.2.14'.

ANNEX A

(*Clause* 11.2.1)

LIST OF TYPE TESTS

Sl No	*Clause Reference of Individual Specification*		*Test Method (see Part 9, Clause)*	*Type Test*
	Part(s)	Sub-clause	Sub-clause	
1	1	7.1	-	Voltage test
2	-	-	2	Intrinsic error
	2	5.2	4.1	Ammeters and voltmeters
	3	5.2	4.2	Wattmeters and varmeters
	4	5.2	4.3 and 4.4	Frequency meters pointer type and Vibrating reed
	5	5.2	4.5,4.6 and 4.7	Phase meters & power factor and synchroscopes
	6	5.2	4.8	Ohmmeters
	8	5.2	4.9 and 4.10	Shunts and resistors
3	-	-	5	Variation tests
	1 to 8	6.2	5.1.1 and 5.1.2	Variation due to ferromagnetic support, fixed & portable
	1	Table 2	5.2	Variation due to ambient temperature
	1	Table 2	5.3	Variation due to humidity
	1	Table 2	5.4.1 and 5.4.2	Variation due to position (with symbol and without marking)
	1	Table 2	5.5	Variation due to magnetic field of external origin
	1	Table 2	5.6	Variation due to ripple of dc measured quantity
	1	Table 2	5.7	Variation due to distortion of ac measured quantity
	1	Table 2	5.8	Variation due to frequency of ac measured quantity
	2	Table 1 of IS 1248 (Part 2)	5.7.1	Ammeters and voltmeters
	3	Table 1 of IS 1248 (Part 2)	5.7.3	Wattmeters and varmeters
	4	Table 2 of IS 1248 (Part 5)	5.7.2	Frequency meters
	5	Table 2 of IS 1248 (Part 5)	5.7.4	Power factor meters, Phase meters
	5	Table 2 of IS 1248 (Part 5)	5.7.4	Synchroscopes
	8	Table 1 of IS 1248 (Part 8)	5.7.5	Accessories
	-	-	5.9	Variation due to voltage/current component of the ac measured quantity
	3	Table 2 of IS 1248 (Part 3)	5.9.1	Wattmeters and varmeters
	4	Table 2 of IS 1248 (Part 4)	5.9.2	Frequency meters
	5	Table 2 of IS 1248 (Part 5)	5.9.3	Phase meters
	5	Table 2 of IS 1248 (Part 5)	5.9.4	Power factor meters

Sl No	*Clause Reference of Individual Specification*		*Test Method (see Part 9, Clause)*	*Type Test*
	Part(s)	Sub-clause	Sub-clause	
	5	Table 2 of IS 1248 (Part 5)	5.9 5	Synchroscopes
	-	-	5.10	Variation due to power factor
	3	Table 2 of IS 1248 (Part 3)	5.10.1	Wattmeters
	3	Table 2 of IS 1248 (Part 3)	5.10.2	Varmeters
	6	6.2.5	5.11	Variation due to battery voltage
	3	Table 2 of IS 1248 (Part 3)	5.12	Variation due to unbalanced current
	1	6.2.4	5.13	Variation due to conductive supports
	1	6.2.2	5.14	Variation due to electric field of external origin
	-	-	5.15	Variation due to simultaneous influence to voltage and power factor
	3	Table 2 of IS 1248 (Part 3)	5.16	Variation due to interaction between the different measuring elements of polyphase instruments
	1	Table 2	5.17	Variation due to auxiliary supply, voltage
	1	Table 2 of IS 1248 (Part 2)	5.18	Variation due to auxiliary supply, frequency
4	1 to 8	7.5	6.1	Limiting values of temperature
5		7.2		Damping
	1 to 4	7.2.1	6.2	Overshoot
	1 to 8	7.2.2	6.3	Response time
		7.2.3		Impedance of external measuring circuit
6		7.4		Permissible overloads
	1 to 5	7.4.2	6.4	Overloads of short duration on instrument
	8	7.4.2	6.5	Overload of short duration on accessories
	1 to 5	7.4.1	6.6	Overload continuous on instrument
	8	7.4.1	6.7	Overload continuous on accessories
	2 and 3	7.1	6 8	Current circuit continuity after high current
7	1 to 5	7.6	6.9	Deviation from zero
8	1	8.6	6.10	Effect of vibration and shock
	5	6.7.2	6.11	Drop-out different frequency for synchroscope
	5	6.7.3	6.12	Pull-in different frequency for synchroscope
	5	6.7.4	5.13	Open circuit for synchroscope
9	1 to 8	7.3	6.14	Self heating
	6	8.1.1	6.15	Ohmmeter maximum current
	3	7.6.2	6.16	Voltage circuits only energized for Wattmeter & Varmeter
	-	-	6.17	Tracking error
	1	8.5	6.18	Range of mechanical zero adjustment
	-	-	3.6 and 3.7	Zero adjustment, mechanical and electrical
	1	10.1	6.19	Performance of marking for terminals and connection diagrams

(ET 12)

Reprography Unit, BIS, New Delhi, India

Measuring Equipment for Basic Electrical Quantities Sectional Committee, ET 12

FOREWORD

This Indian Standard (Part 1) (Fourth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Measuring Equipment for Basic Electrical Quantities Sectional Committee had been approved by the Electrotechnical Division Council.

This standard covers the general requirements of direct acting indicating analogue electrical measuring instruments and their accessories.

This standard was first published in 1958 and was revised in 1968, 1983 and in 1993. The fourth revision had been undertaken to align it with IEC publication.

This standard is one of a series of nine Indian Standards on direct acting indicating analogue electrical measuring instruments and their accessories. Other standards published in this series are as follows:

(Part 2) : 2003 Special reqirements for ammeters and voltmeters (*third revision*)
(Part 3) : 2003 Special reqirements for wattmeters and varmeters (*third revision*)
(Part 4) : 2003 Special reqirements for frequency meters (*third revision*)
(Part 5) : 2003 Special reqirements for phase meters, power factor meters and synchroscopes (*third revision*)
(Part 6) : 2003 Special reqirements for ohmmeters (impedance meters) and conductance meters (*third revision*)
(Part 7) : 2003 Special reqirements for multi-function instruments (*third revision*)
(Part 8) : 2003 Special reqirements for accessories (*third revision*)
(Part 9) : 2003 Test methods (*third revision*)

In the preparation of this standard, assistance has been derived from IEC 60051-1(1997) 'Direct acting indicating analogue electrical measuring instruments and their accessories: Part 1 Definitions and general requirements common to all parts (fifth edition)' issued by the International Electrotechnical Commission (IEC).

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

DIRECT ACTING INDICATING ANALOGUE ELECTRICAL MEASURING INSTRUMENTS AND THEIR ACCESSORIES

PART 1 DEFINITIONS AND GENERAL REQUIREMENTS

(Fourth Revision)

1 SCOPE

1.1 This standard (Part 1) applies to direct acting indicating electrical measuring instruments having an analogue display, such as:

a) Ammeters and voltmeters;
b) Wattmeters and varmeters;
c) Frequency meters of pointer and vibrating-reed types;
d) Phasemeters, power-factor meters and synchroscopes;
e) Ohmmeters, impedance meters and conductance meters; and
f) Multi-function instruments of the above types.

1.2 It also applies to certain accessories used with these instruments, such as:

a) Shunts; and
b) Series resistors and impedance elements.

1.3 If other accessories are associated with instruments, this standard is applicable to the combination of the instrument and the accessory provided that the adjustment has been made for the combination.

1.4 This standard also applies to a direct acting indicating electrical measuring instrument whose scale marks do not correspond directly to its electrical input quantity, provided that the relationship between them is known.

1.5 This standard also applies to instruments and accessories having electronic devices in their measuring and/or auxiliary circuits.

1.6 This standard does not apply to special purpose instruments, which are covered by their own Indian Standards.

1.7 This standard does not apply to special purpose devices, which are covered by their own Indian Standards when they are used as accessories.

1.8 This standard does not contain either requirements for protection against environmental conditions or the relevant tests. However, when necessary, and then only by agreement between the manufacturer and the user, tests to approximate the conditions of use may be selected from IS 9000 series.

This standard does not specify requirements concerning dimensions of instruments (*see* IS 2419) or accessories.

2 REFERENCES

2.1 The following standards are necessary adjuncts to this standard:

IS No.	*Title*
1248	Direct acting indicating analogue electrical measuring instruments and their accessories:
(Part 2) : 2003	Speial requirements for ammeters and voltmeters (*third revision*)
(Part 3) : 2003	Special reqirements for wattmeters and varmetres (*third revision*)
(Part 4) : 2003	Special requirements for frequency meters (*third revision*)
(Part 5) : 2003	Special requirements for phase meters, power factor meters and synchroscopes (*third revision*)
(Part 8) : 2003	Special requirements for accessories (*third revision*)
(Part 9) : 2003	Test methods *(third revision)*
1885	Electrotechnical vocabulary:
(Part 11) : 1966	Electrical measurements
(Part 80) : 1994	General terms on measurements in electricity
(Part 81) : 1993	Electrical measuring instruments
2419 : 1979	Dimensions for panel mounted indicating and recording instruments
3722	Letter symbols and signs used in electrical technology:
(Part 1) : 1983	General guidance on symbols and subscripts (*first revision*)
(Part 2) : 1983	Reference tables for symbols and subscripts (*first revision*)

IS No.	*Title*
8197 : 1976	Terminal markings for elecrical measuring instruments and their accessories
9000	Basic environmental testing procedures for electronic and electrical items:
(Part 7)	Impact tests,
Section 1 : 1979	Shock test
Section 2 : 1979	Bump test
Section 3 : 1979	Drop and topple test
Section 4 : 1979	Free fall test
Section 5 : 1979	Free fall repeated test
(Part 8) : 1981	Vibration (sinusoidal) test
9249 (Part 1) : 1979	Safety requirements for indicating and recording electricals measuring instruments and their accessories: Part 1 Common safety requirements for instruments
9858 : 1981	Safety requirements for elecronics measuring apparatus
12032 (Part 2) : 1987	Graphical symbols for diagrams in the fields of electrotechnology: Part 2 Symbols elements, qualifying symbols and other symbols having general applications

3 TERMINOLOGY

The values of a.c. quantities, given in this standard are r.m.s. values unless otherwise stated.

For the purpose of this standard, the terms as defined in IS 1885 (Parts 11, 80 and 81) shall apply, together with the following additional terms.

3.1 General Terms

3.1.1 *Electrical Measuring Instrument* — A measuring instrument intended to measure an electrical or non-electrical quantity using electrical means.

3.1.2 *Analogue Display Instrument* — A measuring instrument intended to present or display the output information as a continuous function of the measured quantity.

NOTE - An instrument in which a change of the indication occurs by small discrete steps, but which does not have a digital display, is considered to be an analogue instrument.

3.1.3 *Indicating Instrument* — A measuring instrument which displays at any time the value of the measured quantity without recording it.

NOTE — The indicated value may be different from the value of the quantity measured by the instrument and may be in units of a different quantity.

3.1.4 *Direct Acting Indicating Instrument* — An instrument in which the indicating device is mechanically connected to and actuated by the moving element.

3.1.5 *Electronic Measuring Instrument* — A measuring instrument intended to measure an electrical or non-electrical quantity using electronic means.

3.1.6 *Single Function Instrument* — An instrument intended for the measurement of one kind of quantity only.

3.1.7 *Multi-Function Instrument* — An instrument having a single means of indication intended for the measurement of more than one kind of electrical quantity (for example an instrument measuring current, voltage and resistance).

3.1.8 *Fixed Instrument* — An instrument designed to be permanently mounted and which is intended to be connected to (an) external circuit(s) by means of permanently installed leads.

3.1.9 *Portable Instrument* — An instrument specifically designed to be carried out by hand.

NOTE — The instrument is intended to be connected and disconnected by the user.

3.1.10 *Polyphase Instrument* — An instrument for measurement in a polyphase system and arranged for connection to more than one phase of the system.

3.1.11 *Balanced Load Polyphase Instrument* — A polyphase instrument for use in a balanced polyphase system. This does not include a single phase wattmeter scaled in terms of polyphase power.

3.1.12 *Instrument with Magnetic Screen* — An instrument shielded by ferro-magnetic material from the influence of a magnetic field of external origin.

3.1.13 *Astatic Instrument* — An instrument in which the measuring element is so constructed as to be unaffected by a uniform magnetic field of external origin.

3.1.14 *Instrument with Electric Screen* — An instrument shielded by conductive material from the influence of an electric field of external origin.

3.1.15 *Accessory* — An element group of elements or device associated with the measuring circuit of a measuring instrument in order to confer specified characteristics to the measuring instrument.

3.1.15.1 *Interchangeable accessory* — An accessory having its own properties and accuracy, these being independent of these of the instrument with which it may be associated.

NOTE — An accessory is considered to be interchangeable when its rated characteristics are known and marked and are sufficient to enable its errors and variations to be determined without using

the associated instrument. A shunt whose adjustment takes into account an instrument current which is not negligible and which is known, is considered to be interchangeable.

3.1.15.2 *Accessory of limited interchangeability* — An accessory having its own properties and accuracy, which can only be associated with measuring instruments for which certain characteristics are within specified limits.

3.1.15.3 *Non-interchangeable accessory* — An accessory adjusted to take into account the electrical characteristics of a specific measuring instrument.

3.1.16 *Shunt* — A resistor connected in parallel with a measuring circuit of a measuring instrument.

NOTE - A shunt is generally intended to provide a voltage proportional to a current to be measured.

3.1.17 *Series Resistor (Impedance)* — A resistor (impedance) connected in series with a measuring circuit of a measuring instrument.

NOTE - A series resistor (impedance) is generally intended to extend the voltage measuring range of an instrument.

3.1.18 *Instrument Lead* — A lead comprising one or more conductors, specially designed for interconnecting measuring instruments to external circuits or to accessories.

3.1.19 *Calibrated Instrument Lead* — An instrument lead whose resistance has a specified value.

NOTE A calibrated instrument lead is considered as being an interchangeable accessory of a measuring instrument.

3.1.20 *Distortion Factor (Total Harmonic Distortion Factor) (of a Quantity)*

The ratio of

$$\frac{\text{r.m.s. value of the harmonic content}}{\text{r.m.s. value of the non-sinusoidal quantity}}$$

3.1.21 *Ripple Content of a Quantity*

The ratio of

$$\frac{\text{r.m.s. value of the fluctuating component}}{\text{value of the d.c. component}}$$

3.1.22 *Peak Factor* — The ratio of the peak value to the r.m.s. value of a periodic quantity.

3.2 Description of Instruments According to their Method of Operation

3.2.1 *Permanent-Magnet Moving-Coil Instrument* — An instrument which operates by the interaction of the magnetic field due to a current in a movable coil with the field of a fixed permanent magnet.

NOTE - The instrument can have more than one coil, measuring the sum or ratio of the currents in them.

3.2.2 *Moving-Magnet Instrument* — An instrument which operates by the interaction of the field of a movable permanent magnet with the magnetic field due to a current in a fixed coil.

NOTE — The instrument can have more than one coil.

3.2.3 *Moving-Iron Instrument* — An instrument which operates by the attraction between a movable piece of soft magnetic material and the field due to a current in a fixed coil or by the repulsion (and attraction) between one (or more) fixed piece(s) of soft magnetic material and a movable piece of soft magnetic material, both (all) magnetized by a current in a fixed coil.

3.2.4 *Polarized Moving-Iron Instrument* — An instrument comprising a movable piece of soft magnetic material polarized by a fixed permanent magnet and magnetically excited by a current in a fixed coil.

3.2.5 *Electrodynamic Instrument* — An instrument which operates by the interaction of the magnetic field due to a current in a movable coil with the magnetic field due to a current in one or more fixed coils.

3.2.6 *Ferrodynamic Instrument (Iron-Cored Electrodynamic Instrument)* — An electrodynamic instrument in which the electrodynamic effect is modified by the presence of soft magnetic material in the magnetic circuit.

3.2.7 *Induction Instrument* — An instrument which operates by the interaction of the magnetic field(s) of fixed a.c. electromagnet(s) with the magnetic field(s) due to currents which they induce in movable conductive element(s).

3.2.8 *Thermal Instrument (Electrothermal Instrument)* — An instrument which operates by the heating effect(s) of current(s) in it(s) conductor(s).

3.2.8.1 *Bimetallic instrument* — A thermal instrument in which the deformation of a bimetallic element (the materials having different rates of expansion due to a change in temperature), heated directly or indirectly by a current, produces the indication.

3.2.8.2 *Thermocouple instrument* — A thermal instrument making use of the e.m.f. of one or more thermocouples heated by the current to be measured.

NOTE - The e.m.f is often measured using a permanent-magnet moving-coil instrument.

3.2.9 *Rectifier Instrument* — An instrument which is the combination of measuring instrument sensitive to direct current and rectifying device whereby alternating currents or voltages may be measured.

3.2.10 *Electrostatic Instrument* — An instrument the

operation of which depends on the effects of electrostatic forces between fixed and movable electrodes.

3.2.11 *Pointer-Type Frequency Meter* — An instrument which indicates the measured frequency by the relationship between an index and a scale.

3.2.12 *Vibrating-Reed Frequency Meter* — An instrument intended to measure frequency, comprising a set of tuned vibrating-reeds, one or a few of which resonate under the action of an alternating current of the relevant frequency flowing through one or more fixed coils.

3.2.13 *r.m.s. Responding Instruments* — An instrument which, over a specified frequency range, provides an indication which is designed to be proportional to the root-mean-square value of the a.c. measured quantity, even when it is not sinusoidal.

3.2.14 *Phase Meter* — An instrument which indicates the phase angle between two electrical input quantities of the same frequency and of similar waveform.

Such an instrument measures:

a) Phase angle between a voltage and another voltage or between a current and another current, or

b) Phase angle between a voltage and a current.

3.2.15 *Power Factor Meter* — An instrument intended to measure the ratio between the active and the apparent power in an electrical circuit.

In practice, power factor meters indicate the cosine of the phase angle between a current and a related voltage.

3.2.16 *Ratiometer (Quotientmeter)* — An instrument for measuring the ratio (quotient) of two quantities.

3.2.17 *Synchroscope* — An instrument used to indicate the synchronism of two alternate voltages and also the magnitude and sign of the difference between frequencies when they are not equal and magnitude of their phase difference when their frequencies are equal.

3.3 Constructional Features of Instruments

3.3.1 *Measuring Circuit (of an Instrument)* — The part of the electrical circuit internal to the instrument and its accessories, together with the interconnecting leads, if any, which is energized by a voltage or a current, one or both of these quantities being a prime factor in determining the indication of the measured quantity (one of these quantities may be the measured quantity itself).

3.3.1.1 *Current circuit* — A measuring circuit through which flows a current which is a prime factor in determining the indication of the measured quantity.

NOTE — It may be the current directly involved in the measurement or a proportional current supplied by an external current transformer or derived from an external shunt.

3.3.1.2 *Voltage circuit* — A measuring circuit to which is applied a voltage which is a prime factor in determining the indication of a measured quantity.

NOTE — It may be the voltage directly involved in the measurement or a proportional voltage supplied by an external voltage transformer or an external voltage divider or derived by means of an external series resistor (impedance).

3.3.2 *External Measuring Circuit* — The part of the electrical circuit external to the instrument from which a measured value is obtained.

3.3.3 *Auxiliary Circuit* — A circuit, other than a measuring circuit, required for the operation of the instrument.

3.3.3.1 *Auxiliary supply* — An auxiliary circuit which provides electrical energy.

3.3.4 *Measuring Element* — The assembly of those parts of a measuring instrument which are acted upon by a measured quantity, resulting in a movement of the moving element related to that quantity.

3.3.5 *Moving Element* — The moving part of a measuring element.

3.3.6 *Indicating Device* — The part of a measuring instrument which displays values of the measured quantity.

3.3.7 *Index* — The means which, in conjunction with the scale, indicates the position of the moving element of an instrument.

3.3.8 *Scale* — The series of marks and numbers from which, in conjunction with the index, the value of the measured quantity is obtained.

3.3.8.1 *Scale marks* — Marks on the dial for the purpose of dividing it into suitable intervals so that the position of the index may be determined.

3.3.8.2 *Zero scale mark* — The mark on the dial associated with the figure zero.

3.3.8.3 *Scale division* — The distance between any two consecutive scale marks.

3.3.9 *Scale Numbers* — The series of numbers which are associated with the scale marks.

3.3.10 *Dial* — The surface which carries the scale and other marks and symbols.

3.3.11 *Mechanical Zero* — The equilibrium position which the index will approach when the measuring element (if mechanically controlled) is de-energized. This may or may not coincide with the zero scale mark.

In mechanically suppressed zero instruments, the mechanical zero does not correspond to a scale mark.

In instruments without restoring torque the mechanical zero is indeterminate.

3.3.11.1 *Mechanical zero adjuster* — The mechanism by means of which the instrument may be adjusted so that the mechanical zero coincides with the appropriate scale mark.

3.3.11.2 *Mechanical span adjuster* — The mechanism by means of which the instrument may be adjusted so that the lower/upper limit of the measuring range coincides with the appropriate scale mark.

3.3.12 *Electrical zero* — The equilibrium position which the index will approach when the measured electrical quantity is either zero or a set value and the control circuit (if any), producing a restoring torque, is energized.

3.3.12.1 *Electrical zero adjuster* — For an instrument which needs an auxiliary supply, the mechanism by means of which the instrument may be adjusted so that the electrical zero coincides with the appropriate scale mark.

3.3.12.2 *Electrical span adjuster* — For an instrument which needs an auxiliary supply, the mechanism by means of which the instrument may be adjusted so that the lower/upper limit of the measuring range coincides with the appropriate scale mark.

3.4 Characteristics Features of Instruments

3.4.1 *Scale Length* — The length of the line (curved or straight) which passes through the centres of all the shortest scale marks contained between the first and the last scale marks. It is expressed in units of length.

NOTE — If an instrument has more than one scale, each scale may have its scale length. For convenience, the scale length of the instrument is taken to be that of the major scale.

3.4.2 *Span* — The algebraic difference between the upper and lower limits of the measuring range.

It is expressed in units of the measured quantity.

3.4.3 *Measuring Range (Effective Range)* — The range defined by two values of the measured quantity within which the limits of error of a measuring instrument (and/or accessory) are specified.

NOTE - A measuring instrument (and/or accessory) can have several measuring ranges.

3.4.4 *Residual Deflection* — The part of the deflection of a mechanically controlled moving element which remains after the cause producing it has disappeared and all the measuring circuits are de-energized.

3.4.5 *Mechanical Overshoot* — The difference between the extreme indication and the steady indication (expressed in terms of the scale length) when the measured quantity is abruptly changed from one steady value to another.

3.4.6 *Response Time* — The time taken for the indication to first reach and then remain within a band centred on the final steady indication when the measured quantity is abruptly changed from zero (the unenergized condition) to a value such that the final steady indication is a specified proportion of the scale length.

3.5 Characteristic Values

3.5.1 *Nominal Value* — A value of a quantity indicating the intended use of an instrument or accessory. The intended characteristics of instruments and accessories are also nominal values.

3.5.2 *Rated Value* — A value of a quantity assigned, generally by a manufacturer, for a specified operating condition.

3.5.3 *Fiducial Value* — A clearly specified value of a quantity to which the error(s) of an instrument and/or an accessory are referred in order to specify their respective accuracies.

NOTE This value can be, for example, the upper limit of the measuring range, the span or another clearly stated value.

3.6 Influence Quantity, Reference Conditions, Nominal Range of Use and Preconditioning

3.6.1 *Influence Quantity* — Any quantity, generally external to the measuring instrument and/or accessory, which may affect its performance.

3.6.2 *Reference Condition* — The appropriate set of specified values and of specified ranges of values of influence quantities under which the permissible errors of an instrument and/or an accessory are specified.

Each influenee quantity may have either a reference value or a reference range.

3.6.2.1 *Reference value* — A specified value of one of a set of reference conditions.

3.6.2.2 *Reference range* — A specified range of values of one of a set of reference conditions.

3.6.3 *Nominal Range of Use* — A specified range of values which it is intended that an influence quantity can assume without causing a variation exceeding the specified amount.

3.6.4 *Limiting Values of an Influence Quantity* — Extreme values which it is intended that an influence quantity can assume without the instrument or accessory being damaged or permanently altered in such a way that it no longer satisfies the requirements of its accuracy class.

NOTE The limiting values may depend on the duration of their application.

3.6.5 *Preconditioning* — The action whereby a specified value of the measured quantity is applied to the measuring circuit prior to carrying out testing or use of the instrument or accessory.

3.7 Errors and Variations

3.7.1 *(Absolute) Error* — For an instrument, the value obtained by subtracting the true value from the indicated value for an accessory, the value obtained by subtracting the true value from the marked (intended) value.

NOTES

1 Since the true value cannot be obtained by measurement, a value obtained under specified test conditions and at a specified time is used instead. This value is derived from national measurement standards or measurement standards agreed upon by the manufacturer and the user.

2 Attention is drawn to the fact that an error of an accessory may be transformed into an error of the opposite sign when the accessory is used with an instrument.

3.7.2 *Intrinsic Error* — The error of an instrument and/or accessory when under reference conditions.

3.7.3 *Tracking Error* — The difference between the indication of a measuring instrument and the proportional value of the measured quantity at points within the scale, the instrument having been previously set to have no error at two points.

3.7.4 *Variation* — The difference between the two indicated values for the same value of the measured quantity of an instrument or the two true values of an accessory when a single influence quantity assumes successively two different specified values within the nominal range of use.

3.8 Accuracy, Accuracy Class and Class Index

3.8.1 *Accuracy* — For a measuring instrument, the quality which characterizes the closeness of the indicated value to the true value for an accessory, the quality which characterizes the closeness of the marked (intended) value to the true value.

NOTE The accuracy of a measuring instrument or of an accessory is defined by the limits of intrinsic error and by the limits or variations.

3.8.2 *Accuracy Class* — A group of measuring instruments and/or accessories which meet certain metrological requirements intended to keep permissible errors and variations within specified limits.

3.8.3 *Class Index* — The number which designates the accuracy class.

NOTE — Some instruments and/or accessories may have more than one class index.

4 DESCRIPTION, CLASSIFICATION AND COMPLIANCE

4.1 Description

Instruments and/or accessories shall be described according to their method of operation or their nature as given in 3 and/or by their special characteristics as given in the relevant parts.

4.2 Classification

Class indices shall be selected from a 1-2-5 sequence and the decimal multiples and sub-multiples thereof.

In addition, class indices 0, 3, 1, 5, 2, 5 and 3 may be used for instruments, class index 0.15 for frequency meters and class index 0.3 for accessories.

4.3 Compliance with the Requirements of this Standard

Instruments and accessories marked with a class index shall comply with the relevant requirements of this standard relating to their class index.

The recommended test methods for checking compliance with the requirements of this standard are given in IS 1248 (Part 9).

In case of dispute, the test methods of IS 1248 (Part 9) are referee methods.

4.3.1 If, for the determination of intrinsic errors preconditioning is specified, the manufacturer shall state the preconditioning period and the value(s) of the measured quantity(ies). The preconditioning period shall not exceed 30 min.

4.3.2 Instruments and accessories shall be adequately packed to ensure that, after transport to the user, under normal conditions, they comply with the requirements of this standard relating to their class index.

5 REFERENCE CONDITIONS AND INTRINSIC ERRORS

5.1 Reference Conditions

5.1.1 The reference values of the influence quantities shall be as given in Table 1.

5.1.2 The reference values for the ambient temperature shall be 27°C.

5.1.3 Reference conditions different from those given in Table 1 may be specified, but they shall then be marked in accordance with 9.

5.2 Limits of Intrinsic Error, Fiducial Value

When the instrument together with its non-interchangeable accessory(ies) (if any) or accessory is

Table 1 Reference Conditions and Tolerances for Testing Purposes Relating to the Influence Quantities

(*Clauses* 5 1.3 *and* 5.2)

Influence Quantity		Reference Conditions Unless Otherwise Marked		Tolerance Permitted for Testing Purpose, Applicable for a Single Reference Value[1]	
				Class indices 0 3 and smaller	Class indices 0 5 and greater
(1)		(2)		(3)	(4)
Ambient temperature		27°C		±1°C	±2°C
Humidity		Relative humidity 45 to 75 percent			
Ripple of d c measured quantity		Ripple content zero		Ripple content 1 percent	Ripple content 3 percent
Distortion of a c measured quantity	Distortion factor	Zero —		1 Rectifier instruments, non r m s responding electronic instruments and instruments which employ phase-shifting networks in their measuring circuits distortion factor less than or equal to half the class index or 1 percent whichever is smaller 2 Other instruments distortion factor not exceeding 5 percent	
	Peak factor	$\sqrt{2}$, Approximately 1 414 (sine wave)		± 0 05	
Frequency of a c measured quantity except for wattmeters, varmeters, frequency meters and power factor meters		45 Hz to 65 Hz		± 2 percent of the reference value or ± 1 % of the reference range for frequency (if any), whichever is the smaller	
Position[2]		Fixed instruments mounting plane vertical Portable instruments mounting plane horizontal		± 1°	
Nature and thickness of panel or support		*Nature*	*Thickness*		
	F 37	Ferrous	1 mm	± 0 1 1 mm or ± 0 5mm, whichever is smaller	
	F 38	Ferrous	Any		
	F 39[3]	Non-ferrous	Any	—	
	None	Any	Any	—	
Magnetic field of external origin		Total absence		40 A/m[4] at frequencies from d c to 65 Hz in any direction	
Electric field of external origin		Total absence		1 kV/m at frequencies from d c to 65 Hz in any direction	
Auxiliary Supply	Voltage	Nominal value or nominal range		± 5 percent of the nominal value[5]	
	Frequency	Nominal value or nominal range		± 1 percent of the nominal value[5]	

[1] These tolerances apply when a single reference value is specified in this table or is marked by the manufacturer For a reference range, no tolerance is allowed

[2] Instruments provided with a level indicator shall be tested with the instrument set level using the level indicator

[3] These symbols (or lack or symbol) refer to the nature and thickness of the panel or support on which the instrument is mounted (*see* Table 3)

[4] 40 A/m is approximately the highest value of the earth's magnetic field

[5] Unless a different tolerance is stated by the manufacturer

under the reference condition given in Table 1 and is used between the limits of its measuring range and in accordance with the manufacturer's instructions, the intrinsic error, expressed as a percentage of the fiducial value, shall not exceed the limits appropriate to its accuracy class. Values stated in Table 1 of corrections supplied with the instrument or accessory shall not be taken into account in determining the errors.

NOTES

1 The intrinsic error includes other errors such as those due to friction, amplifier drift, etc

2 The accuracy classes relating to each type of instrument or accessory are given in the appropriate parts (*see* 4).

5.2.1 *Correspondence Between Intrinsic Error and Accuracy Class*

The maximum permissible error is related to the accuracy class such that the class index is used as the limits of error, expressed as percentage with positive and negative signs.

NOTE -- For example, for a class index of 0 05, the limits of intrinsic error are ± 0.05 percent of the fiducial value

5.2.2 *Fiducial Value*

The fiducial value for each type of instrument and accessory is given in each relevant part.

6 NOMINAL RANGE OF USE AND VARIATIONS (*see* ANNEX B)

6.1 Nominal Range of Use

6.1.1 The limits of the nominal range of use for influence quantities shall be as given in Table 2.

Table 2 Limits of the Nominal Range of Use and Permissible Variations

(*Clauses* 6.1.1, 6.1.2, 6.1.2.1, 6.1.2.2, 6.2, 6.2.1.3 *and* 6.3.2.1)

Influence Quantity		Limits of the Nominal Range of Use Unless Otherwise Marked	Permissible Variation Expressed as a Percentage of the Class Index	For the Recommended Tests, Ref to Cl of IS 1248 (Part 9)
(1)		(2)	(3)	(4)
Ambient temperature		Reference temperature ±10°C or lower limit of reference range –10°C and upper limit of reference range +10°C	100 percent	3 2
Humidity		Relative humidity 25 percent and 80 percent	100 percent	3 3
Ripple on d c measured quantity		*See* relevant parts		3 6
Distortion of a c measured quantity		Distortion factor : *see* relevant parts		3 7
		Peak factor : *see* relevant parts		Under consideration
Frequency on a c measured quantity		*See* relevant parts		3 8
Position[1]		Horizontal and vertical if the reference position is not marked	100 percent	3 4
		About 5° in any direction from reference position	50 percent	
Magnetic field of external origin		*See* **6.2.1** and the relevant parts		3 5
Electric field of external origin (electrostatic instruments only)		20 kV/m at d.c. and 45Hz to 65Hz (*see* **6.2.2.**)	100 percent	3 14
Auxiliary Supply	Voltage	Reference value ±10 percent or lower limit of reference range - 10 percent and upper limit of reference range +10 percent	50 percent	3 17
	Frequency	Reference value ±5 percent or lower limit of reference range –5 percent and upper limit of reference range +5 percent	50 percent	3 18

[1] Instruments provided with a level indicator shall always be set correctly for position using the level indicator. These instruments need not therefore be tested for variation due to position.

6.1.2 When a manufacturer assigns and marks a nominal range of use which is different from that shown in Table 2, it shall include the reference range (or reference value with permitted tolerances) and will normally exceed it in at least one direction.

6.1.2.1 For values in the nominal range of use beyond the reference range (or reference value), the permissible variation is as stated in Table 2.

Example

For an instrument having class index of 0.2, the variation due to a lack of level of 5° in any direction shall not exceed:

$$0.2 \text{ (percent)} \times \frac{50}{100} = 0.1 \text{ percent of the fiducial value.}$$

6.1.2.2 When the influence quantity is not one of those shown in Table 2, the relevant permissible variation shall be stated by the manufacturer and shall not exceed 100 percent of the class index.

6.2 Limits of Variations

When an instrument or an accessory is under reference conditions and a single influence quantity is varied, the variation shall not exceed the values given in Table 2 and in **6.2.1**, **6.2.2** and **6.2.3**.

6.2.1 *Variation Due to a Magnetic Field of External Origin*

6.2.1.1 When the instrument is not marked with symbol F-30 (Table 3), the magnetic field strength in the test equipment shall be 0.4 kA/m.

6.2.1.2 For instruments marked with symbol F-30 (Table 3), the magnetic field strength in the test equipment shall have a value in kilo-amperes per metre as shown in the symbol.

6.2.1.3 Under the conditions of **6.2.1.1** and **6.2.1.2**, the variation shall not exceed the limits given in Table 2 of the relevant parts.

6.2.2 *Variation Due to an Electric Field of External Origin (Electrostatic Instruments Only)*

The variation due to an electric field of external origin at d.c. and 45 Hz to 65 Hz, having a strength of 20 kV/m and under the most unfavourable conditions of phase and orientation, shall not exceed 100 percent of the class index.

If the instrument is marked with symbol F-34 (Table 3), the field strength is made equal to the value given in the symbol.

6.2.3 *Variation Due to Ferromagnetic Supports*

The error of instruments which are mounted on a panel of the nature and thickness implied by the relevant symbol F-37, F-38 or F-39 (Table 3) or on a panel of any nature and thickness when not so marked — shall remain within the limits of the intrinsic error.

For the recommended test, *see* **3.1** of IS 1248 (Part 9).

6.2.4 *Variation Due to Conductive Supports*

For the recommended test, *see* **3.13** of IS 1248 (Part 9).

Instruments shall meet the requirements for intrinsic errors relating to their class index when used on a panel or support of high conductivity unless other requirements are given in a separate document and are shown by marking with symbol F-33 (Table 3).

6.3 Conditions for the Determination of Variations

6.3.1 If preconditioning is specified for the determination of variations, the manufacturer shall state the preconditioning period and the value(s) of the measured quantity(ies) and of the auxiliary supply, if any.

The preconditioning period shall not exceed 30 min.

6.3.2 The variations shall be determined for each influence quantity separately.

During each test all influence quantities shall be maintained at their reference conditions except for the influence quantity for which the variation shall be determined.

6.3.2.1 When an influence quantity has a reference value, the influence quantity shall be varied between that value and any value within the limits of the nominal range of use as given in Table 2, unless otherwise marked.

6.3.2.2 When an influence quantity has a reference range, the influence quantity shall be varied from each limit of the reference range to the adjacent limit of the nominal range of use.

7 FURTHER ELECTRICAL AND MECHANICAL REQUIREMENTS

7.1 Voltage Test and Other Safety Requirements

The requirements for the voltage tests, insulation resistance tests and constructional requirements relating to safety are included in IS 9249 (Part 1).

For additional requirements relating to electronic devices of instruments and/or accessories, IS 9858 shall be applied.

7.2 Damping

The damping of instruments, except for instruments having an intentionally long response time, and unless otherwise specified in the relevant part, shall comply with the following requirements.

7.2.1 *Mechanical Overshoot*

For the recommended test, *see* **4.2** of IS 1248 (Part 9).

7.2.1.1 For instruments having a total angular deflection of less than 180°, the mechanical overshoot shall not exceed 20 percent of the scale length. For other instruments, the limit shall be 25 percent.

7.2.2 *Response Time*

Unless otherwise agreed between the manufacturer and the user, the departure of the index from the position of rest shall not exceed 1.5 percent of the scale length at any time after 4s following the sudden application of an excitation producing a change of final indication of two-thirds of the scale length.

For the recommended test, *see* **4.3** of IS 1248 (Part 9).

7.2.3 *Impedance of the External Measuring Circuit*

When the characteristics of the circuit into which the instrument is connected may affect the damping, the external circuit impedance shall be as stated in the relevant part or otherwise specified by the manufacturer.

7.3 Self-Heating

For the recommended test, *see* **4.14** of IS 1248 (Part 9).

7.3.1 Instruments, together with their non-interchangeable accessories (if any), interchangeable accessories and accessories of limited interchangeability shall comply with the requirements corresponding to their class index after being continuously operated at any time after the completion of the specified preconditioning period (if any).

For testing:

a) Instruments shall be energized to give an indication of about 90 percent of the upper limit of the measuring range;
b) Shunts shall be energized at about 90 percent of their nominal value; and
c) Series resistors (impedances) shall be energized at about 90 percent of their rated values.

7.3.2 The variation shall not exceed the value corresponding to 100 percent of the class index for the instrument as well as for the instruments together with its accessories.

7.3.3 Instruments and accessories intended for intermittent use (for example those provided with a non-locking switch) are excluded from the requirements relating to self-heating.

7.3.4 The requirements of **7.3.1**, **7.3.2** and **7.3.3** do not apply to ohmmeters.

7.4 Permissible Overloads

7.4.1 *Continuous Overload*

Requirements for continuous overload are given in the relevant parts.

7.4.2 *Overloads of Short Duration*

Requirements for overloads of short duration are given in the relevant parts.

7.5 Limiting Values of Temperature

For the recommended test [*see* **4.1** of IS 1248 (Part 9)].

7.5.1 Unless otherwise specified, instruments and/or accessories shall operate without incurring permanent damage when subjected to the ambient temperatures stated below:

a) Instruments of class indices 0.3 and smaller: –0°C to +40°C;
b) Instruments of class indices 0.5 and greater and accessories of all class indices: –10°C to + 55°C;
c) Instruments which incorporates batteries and/ or which have built-in electronic devices and are marked with symbol F-20 or F-21 (Table 3) : 0°C to +40°C.

7.5.2 Absence of permanent damage is inferred if, on return to reference conditions, the instruments and/or accessories comply with the requirements relating to intrinsic error. Adjustment of the instrument zero is permissible.

7.6 Deviation from Zero

Requirements for deviation from zero and for return to zero are given in the relevant parts.

8 CONSTRUCTIONAL REQUIREMENTS

8.1 Sealing to Prevent Access

When the instrument is sealed, access to the measuring element and to the accessories within the case shall not be possible without destroying the seal.

8.2 Scales

8.2.1 *Scale Divisions*

The intervals shall correspond to 1, 2 or 5 times the unit of the measured or indicated quantity or that unit multiplied or divided by 10 or 100.

For multi-range and/or multi-scale instruments, the above requirements shall be fulfilled for at least one measuring range or scale.

8.2.2 *Scale Numbering*

The numerals of the scale (whole number or decimal)

marked on the dial should preferably not have more than three digits. SI units and their prefixes should be used in association with the scale numbering. For example 1 200 A should be written as 1.2 kA or 1 000 mV should be written as 1.0 V.

8.2.3 *Direction of Deflection*

The direction of deflection of the index of an instrument should be from left to right or from bottom to top with increasing measured quantity.

When the angular deflection of the index exceeds 180°, the deflection with increasing measured quantities should be clockwise.

On multi-scale instruments, at least one of the scales shall be such as to comply with the above requirements.

8.2.4 *Limits of the Measuring Range*

If the measuring range does not occupy the whole scale length, the limits of the measuring range shall be clearly identified.

8.2.4.1 When the value of the scale divisions or the nature of the scale marks enables the measuring range to be identified without ambiguity, no marking is necessary. An example of this method is given in Fig. 1.

NOTE Sub-divisions are omitted outside the measuring range.

8.2.4.2 When there is only one scale and marking is necessary, the limits of the measuring range shall be identified by means of small filled-in dots. An example of this method is given in Fig. 2.

NOTE — The measuring range (.....).

8.2.4.3 When there is more than one scale and marking is necessary, the limits of the measuring range shall be identified either by small filled-in dots or by means of widened scale arcs. An example of this latter method is given in Fig. 3.

8.3 Indication of Out-of-Range Values of the Measurand

When the value of the measurand is such that it would provide an indication not between the limits of a scale range, a clear out-of-range indication of this shall be provided.

NOTE — The method of out-of-range indication may be, for example, by permitting the index to pass above (or below) the extreme scale marks in a clearly visible manner.

8.4 Preferred Values

The preferred values shall be used in the absence of a special agreement between the manufacturer and the user.

Requirements for preferred values are given in the relevant parts.

8.5 Adjusters, Mechanical and/or Electrical

8.5.1 *Zero Adjuster(s)*

When an instrument is fitted with zero adjuster(s), intended for use by the user, it is preferable that it (they) be accessible from the front of the case. In mechanically suppressed zero instruments (for example 0/4-20 mA or 0/1-5 V) the pointer shall be adjusted to coincide with the lowest scale mark with appropriate signal applied to the instruments.

The total range of adjustment shall be not less than 2 percent of the scale length or 2°, whichever is less, and the fineness of setting shall be appropriate to the class index of the instrument.

NOTE By appropriate, it is understood that the fineness of the setting is such as to permit setting to within 1/5 of the class index.

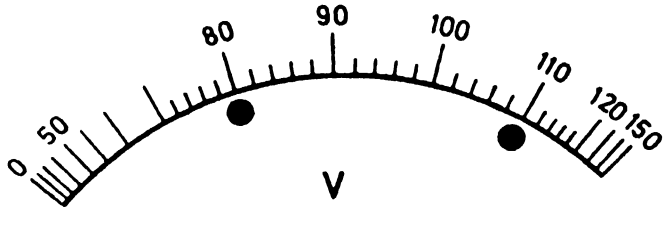


FIG. 1 MEASURING RANGE 8A TO 50A

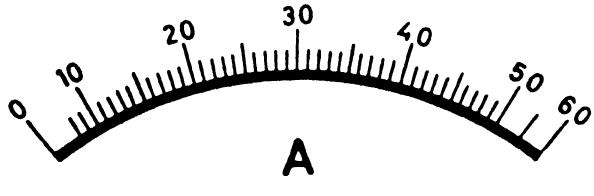


FIG. 2 MEASURING RANGE 80V TO 110V

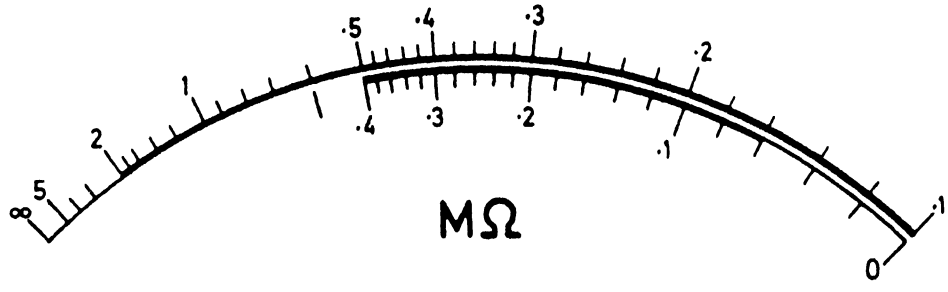


FIG. 3 MEASURING RANGES 0.06 MΩ TO 0.4 MΩ AND 0.1 MΩ TO 2 MΩ

For instruments where the effective centre of rotation cannot readily be determined, the requirement relating to 2° is not applicable.

The ratio between the higher and lower ranges of adjustment on either side of the zero mark shall not be greater than 2.

For the recommended test, *see* **4.18** of IS 1248 (Part 9).

8.5.2 *Span Adjuster(s)*

When an instrument is fitted with span adjuster(s), intended for use by the user, it is preferable that it (they) be accessible from the front of the case.

The total range of the adjustment shall be not less than 2 percent of the scale length or 2°, whichever is the less, and the fineness of setting shall be appropriate to the class index of the instrument.

NOTE - By appropriate, it is understood that the fineness of the setting is such as to permit setting to within 1/5 of the class index

For instruments where the effective centre of rotation cannot readily be determined, the requirement relating to 2° is not applicable.

The ratio between the higher and lower ranges of adjustment on either side of the zero mark shall not be greater than 2.

For the recommended test, *see* **4.18** of IS 1248 (Part 9).

8.6 Effects of Vibration and Shock

Unless otherwise agreed, instruments and accessories of class indices 1 and greater shall be capable of withstanding the vibration and shocks of the following type tests.

8.6.1 *Vibration Test*

The test method given in IS 9000 (Part 8) shall be used with the details specified below:

a) Sweep frequency range : 10 Hz – 55 Hz – 10 Hz
b) Displacement amplitude : 0.15 mm
c) Number of sweep cycles : 5
d) Sweep rate : 1 octave per min

The direction of vibration is vertical: the instrument is fastened in its normal position of use.

8.6.2 *Shock Test*

The method given in IS 9 000 (Part 7/Sec 1) shall be used with the details specified below:

a) peak acceleration:
   1) 147 m/s^2 (15 g_n),
   2) 490 m/s^2 (50 g_n),
b) for the peak acceleration in case (1) no information is needed. In case (2) the manufacturer shall state the value 490 m/s^2 of the peak acceleration;
c) pulse shape: half sine;
d) number of shocks: three in both directions of three mutually perpendicular axes (total of 18 shocks);
e) duration of pulse: 11 ms.

The instrument is mounted so that one of the three shock axes is parallel to the axis of rotation of the moving element.

8.6.3 The change of error due to the effects of vibration and shock shall not exceed a value corresponding to 100 percent of the class index.

9 INFORMATION, GENERAL MARKING AND SYMBOLS

9.1 Information

The following information shall be given by the manufacturer:

a) Unit(s) of measured quantity(ies).
b) Manufacturer's name or trade-mark or that of the responsible supplier.
c) Type reference, if any, given by the manufacturer.
d) Serial number for instruments and accessories of class indices 0.3 and smaller. Serial number of date of manufacturer (at least the year) for instruments and accessories of class indices 0.5 and greater.

e) Rated value(s).

f) Nature of measured quantity(ies) and number of measuring elements.

g) Accuracy class(es).

h) Reference value or reference range for temperature for instruments and accessories of class indices 0.5 and smaller.

i) Reference value(s) or reference range(s) for each influence quantity (other than temperature) given in Table 1 if different from the values given in Table 1 and the reference values or reference ranges for any other relevant influence quantities not given in Table 1.

j) Nominal ranges of use for the influence quantities of Table 2 if the values are different. Nominal ranges of use for any other relevant influence quantities not given in Table 2.

k) Value of acceleration.

l) Instructions for the use of the instrument and/or accessory(ies) when necessary.

m) Method of operation of the instrument.

n) The burden expressed in voltamperes at nominal current and/or nominal voltage.

o) Peak factor, if applicable.

p) When relevant, reference position and nominal range of use for position.

q) Temperature limits and other requirements for transport, storage and use, if necessary.

r) Test voltage.

s) For an instrument whose scale marks do not correspond directly to its electrical input quantity, the relationship between them. This does not apply to an instrument having a non-interchangeable accessory.

t) Preconditioning period if not negligible and the value(s) of the measured quantity(ies) to be used for preconditioning.

u) Symbol of the accessory for which the instrument has been adjusted, if relevant.

v) Transformation ratio(s) of instrument transformer(s) for which the instrument has been adjusted, if relevant.

w) Value of the total resistance of calibrated instrument leads, if relevant.

x) Impedance of the external measuring circuit, if relevant.

y) Statement concerning an intentionally long response time, if relevant.

z) Any other essential information.

9.2 Marking, Symbols and Their Locations

The marking and symbols shall be and remain legible and indelible. SI units, together with their prefixes, shall be marked using the symbols given in IS 3722 (Parts 1 and 2).

The symbols specified in Table 3 shall be used, where relevant.

9.2.1 The following information shall be marked on the dial or on a part which is visible while the instrument is in use (marking on the dial shall not impede the clear reading of the scale):

a) Symbol(s) Table 3

f) [symbol(s) B-1 ... B-10]; Table 3

g) [symbol(s) E-1 ... E-10]; Table 3

p) [symbol D-1 ... D-6]; Table 3

t) [symbol(s) C-1 ... C-3];

z) [symbol F-33 if some other essential information is given in a separate document].

aa) [symbol according to IS 9249 (Part 1)].

9.2.2 The following information shall be marked on the dial or anywhere on the case (marking on the dial shall not impede the clear reading of the scale):

b); c); d); h);

m) [symbol(s) F-1 ... F-22, F-27, F-28, F-29, if relevant]; Table 3

u) (symbol F-23 ... F-26); Table 3

v) where relevant, the nature and thickness of the panel or support (symbol F-37 ... F-39). Table 3.

In addition, if the reference values of the influence quantities are different from those given in Table 1, they shall be marked as follows:

a) Magnetic field of external origin (symbol F-30 and if relevant F-28 and/or F-29), Table 3

b) Electric field of external origin (symbol F-34 and if relevant F-27], Table 3.

9.2.3 The following information shall be marked on the dial or anywhere on the case or given in a separate document (if any) (marking on the dial shall not impede the clear reading of the scale):

e); i); n); q); s); t); w); x).

9.2.4 Documentation (if any) shall state:

b); c); k); l);

o) (only for instruments containing electronic devices in their measuring circuits);

y) (by agreement between the manufacturer and

the user); any information of **8.2.3** which is not marked.

9.2.5 Markings for accessories and special markings for instruments, together with their locations, are given in the relevant parts.

9.2.6 By agreement between the manufacturer and the user, any or all of the information may be omitted.

9.3 Markings Relating to the Reference Values and Nominal Ranges of Use of Influence Quantities

9.3.1 Where a reference value or a reference range is different from that given in Table 1, it shall be marked and shall be distinguished by being underlined. It is identified by the symbol of the unit in which it is measured.

9.3.2 When the nominal range of use is different from that given in Table 2 it shall be marked. The marking is carried out in conjunction with marking the reference value or reference range. This then requires the marking of the reference value or reference range even if it would not otherwise be necessary.

Table 3 Symbols for Marking Instruments and Accessories

(*Table* 1, and *Clauses* 6.2.1.1, 6.2.2, 6.2.3 *and* 6.2.4)

Symbols for units of measurements and their prefixes are given in IS 3722 (Parts 1 and 2). For convenience, the symbols most likely to be needed for marking instruments and accessories and a list of the SI prefixes are given below.

A SYMBOLS FOR SI UNITS

Units and Quantities

Item	Symbol
Ampere	A
Decibel	dB
Hertz	Hz
Ohm	Ω
Second	s (lower case)
Siemens	S (capital)
Tesla	T
Volt	V (capital)
Voltampere	VA (capitals)
Voltampere reactive	var (lower case)
Watt	W (capital)
Power factor	cos ϕ or cos φ
Degree Celsius	°C

SI Prefixes

Item		Symbol
exa	10^{18}	E
péta	10^{15}	P
Téra	10^{12}	T
giga	10^{9}	G
méga	10^{6}	M (capital)
kilo	10^{3}	k (lower case)
hecto [1]	10^{2}	h (lower case)
déca [1]	10	da (lower case)
déci [1]	10^{-1}	d (lower case)
centi [1]	10^{-2}	c (lower case)
milli	10^{-3}	m (lower case)
micro	10^{-6}	μ
nano	10^{-9}	n
pico	10^{-12}	p
femto	10^{-15}	f
atto	10^{-18}	a

Table 3 (*Continued*)

B Nature of Measured Quantity and Number of Measuring Elements				
No.	**Item**		**Symbol**	
B-1	Direct current circuit and/or d c responding measuring element	(A-1 1)*		
B-2	Alternating current circuit and/or a c responding measuring element	(A-1 2)*		
B 3	Direct and/or alternating current circuit and/or d c and a c responding measuring element	(A-1 3)*		
B 4	Three-phase alternating current circuit (general symbol)	3 ~ †		The symbols in this column are given for information only
B 6	One measuring element (E) for three-wire network	3 ~ 1E†		
B 7	One measuring element (E) for four-wire network	3N ~ 1E†		
B 8	Two measuring elements (E) for three-wire network with unbalanced loads	3 ~ 2E†		
B 9	Two measuring elements (E) for four-wire network with unbalanced loads	3N ~ 2E†		
B-10	Three measuring elements (E) for four-wire network with unbalanced loads	3N ~ 3E†		

C Safety [for Application, *see* IS 9249 (Part 1)]		
D Position of Use		
D-1	Instrument to be used with the dial vertical	
D 2	Instrument to be used with the dial horizontal	
D-3	Instrument to be used with the dial inclined (for example 60°) from the horizontal plane	

Table 3 (*Continued*)

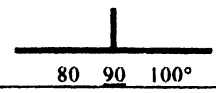
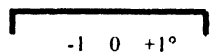
No	Item	Symbol
D 4	Example for instrument to be used as D-1, nominal range of use from 80° to 100°	
D 5	Example for instrument to be used as D-2, nominal range of use from -1° to +1°	
D 6	Example for instrument to be used as D-3, nominal range of use from 45° to 75°	
	E Accuracy Class	
E 1	Class index (for example 1) except when the fiducial value corresponds to the scale length or the indicated value or the span	1
E 2	Class index (for example 1) when the fiducial value corresponds to the scale length	
E 3	Class index (for example 1) when the fiducial value corresponds to the indicated value	
E 10	Class index (for example 1) when the fiducial value corresponds to the span	
	F General Symbols [*see also* IS 8197 and IS 12032 (Part 2)]	
F 1	Permanent-magnet moving-coil instrument	
F 2	Permanent-magnet ratiometer (quotientmeter)	
F-3	Moving permanent-magnet instrument	
F 4	Moving permanent-magnet ratiometer (quotientmeter)	
F 5	Moving-iron instrument	
F-6	Polarized moving-iron instrument	
F-7	Moving-iron ratiometer (quotientmeter)	

Table 3 (*Continued*)

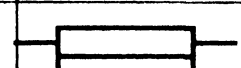
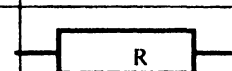
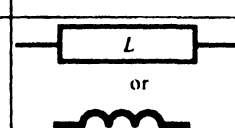
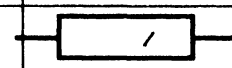
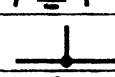
No.	Item	Symbol
F-8	Ironless electrodynamic instrument	
F-9	Iron-cored electrodynamic (ferro-dynamic) instrument	
F-10	Ironless electro-dynamic ratiometer (quotientmeter)	
F-11	Iron-cored electro-dynamic (ferro-dynamic) ratiometer (quotientmeter)	
F-12	Induction instrument	
F-13	Induction ratiometer (quotientmeter)	
F-15	Bimetallic instrument	
F-16	Electrostatic instrument	
F-17	Vibrating-reed instrument	
F-18	Non-insulated thermocouple (thermal converter)	 [1]
F-19	Insulated thermocouple (thermal converter)	 [1]
F-20	Electronic device in a measuring circuit	 [3]
F 21	Electronic device in an auxiliary circuit	 [3]
F-22	Rectifier	 [1]
F-23	Shunt	
F-24	Series resistor	
F-25	Series inductor	

Table 3 (*Concluded*)

No	Item	Symbol
F 26	Series impedance	
F 27	Electric screen	
F 28	Magnetic screen	
F 29	Astatic instrument	ast
F 30	Magnetic field strength expressed in kiloamperes per meter producing a variation corresponding to the class index (for example 2 kA/m)	 2 kA/m
F 31	Earth (ground) terminal (general symbol)	 [4] (A 2 1)*
F 32	Zero (span) adjuster	
F 33	Refer to a separate document	
F 34	Electric field strength expressed in kilovolt per meter, producing a variation corresponding to the class index (for example 10kV/m)	 10 kV/m
F 35	General accessory	 [5]
F 37	Ferrous support of thickness t mm	Fex
F 38	Ferrous support of any thickness	Fe
F 39	Non ferrous support of any thickness	Nfe
F 42	Frame or chassis terminal	 (A 2 2)*
F 43	Protective earth (ground) terminal	 (A 2 3)*
F 44	Noiseless earth (ground) terminal	 (A 2 4)*
F 45	Signal low terminal	
F 46	Positive terminal	 (A 2 6)*
F 47	Negative terminal	(A 2 7)*
F 48	Resistance range setting control	 Ω
F 49	Overload protection device fitted	
F 50	Overload protection device reset control	

* Numbers identified by "*" are the reference numbers of the symbols given in IS 8197

† Symbols identified by "†" are derived from symbol 02-02-04 in IS 12032 (Part 2)

These items are non-preferred and their use should be avoided The symbol of a prefix (if needed) immediately precedes without a space the symbol of a unit If there is a number, it is followed by a space before the prefix (if any) and the unit For example 27°C, 120mV

[3] Symbol F-2 is given for information only It shall not be used on new designs of instruments

[4] If symbols F-18, F-19, F-20, F-21 or F-22 are combined with a symbol of an instrument, such as symbol F-1, the device is incorporated

[4] Symbol F-31 is deprecated One of the more explicit symbols F-42, F-43, F-44 or F-45 should be used instead

[5] Symbol F 35 denotes that a device is external and shall be combined with one of the symbols F-18, F-19, F-20, F-21 or F 22

9.3.3 The marking .s done by writing the limits of the nominal range of use and the reference value (or range) in ascending order, each number separated from its neighbour by three dots

For Example

35, 50, 60 Hz implies a reference frequency of 50 Hz and a nominal range of use for frequency from 35 Hz to 60 Hz

Similarly 35, 45, 55, 60 Hz implies a reference frequency range of from 45 Hz to 55Hz and a nominal range of use for frequency from 35 Hz to 60 Hz

9.3.4 When any limit of the nominal range of use is the same as the reference value or the adjacent limit of the reference range, the number indicating the reference value or the limit of the reference range shall be repeated for the limit of the nominal range of use

For Example

23, 23, 37°C implies a reference temperature of 23°C and a nominal range of use for temperature from 23°C to 37°C

Similarly 20, 20, 25, 35°C implies a reference temperature range from 20°C to 25°C and a nominal range of use for temperature from 20°C to 35°C

10 MARKINGS AND SYMBOLS FOR TERMINALS

10.1 Requirements for Markings

10.1.1 The marking shall be applied on or adjacent to the relevant terminal

10.1.2 If there is insufficient space adjacent to a terminal for the marking specified, a permanently attached nameplate shall be provided having details of the terminals and identifying them in an unambiguous way

10.1.3 The marking shall be and remain legible and indelible and of a colour which contrasts with the background or shall be moulded

10.1.4 A marking shall not be applied to a removable part of a terminal (such as a terminal head)

10.1.5 If markings are applied to a cover over several terminals, it shall not be possible to fit the cover so that the markings become incorrect

10.1.6 When a diagram of connections is supplied, the marking for a terminal shall be identical to that on the diagram of connections relating to that terminal

10.2 Earthing (Grounding) Terminals

10.2.1 Terminals which are required to be connected to a protective earth (ground) for reasons of safety shall be marked with symbol F-43 (Table 3)

10.2.2 Terminals which are required to be connected to a noiseless earth (ground) to prevent impairment of performance shall be marked with symbol F-44 (Table 3)

10.2.3 Terminals which are connected to accessible conductive material but which are not necessarily required to be connected to earth (ground) shall be marked with symbol F-42 (Table 3)

10.3 Earthing (Grounding) Terminals

If a terminal of a measuring circuit is intended to be kept at or near to earth (ground) potential (for example for safety or functional reasons), it shall either be marked with a capital N if it is intended to be connected to the neutral conductor of an ac supply circuit, or shall be marked with symbol F-45 (Table 3) in all other circumstances

These markings are additional to and shall follow any other markings prescribed for the relevant terminals

10.4 Special Markings for Terminals

Special markings are given in the relevant parts

11 TESTS TO PROVE COMPLIANCE WITH THIS STANDARD

11.1 The performance of instruments and accessories specified in this standard may be established using the tests given in IS 1248 (Part 9) and these tests may be supplemented by tests given in other relevant Indian Standards

11.2 Tests under two categories are required type tests and routine tests

11.2.1 Type tests shall be made on a single specimen of each design or on a small number of specimens and shall be carried out as per sequence given at Annex A Information on general test condition are given at Annex C

11.2.2 Following tests shall be carried out on all items as routine test

a) Insulation resistance test (*see* **7.1**),

b) Voltage test (*see*7.1),

c) Test for variation due to position (*see* **6** and Table 2), and

d) Test for intrinsic errors (*see* **5**)

NOTE Routine tests are usually sufficient when made periodically during the life of an instrument of an accessory to ensure continued accurate performance and are normally used for recalibration

ANNEX A

(*Clause* 11.2.1)

LIST OF TYPE TESTS

Sl No.	*Clause Reference of Individual Specification*		*Test Method (see Part 9, Clause)*	*Type Test*
	Part(s)	Sub-clause	Sub-clause	
1	1	7.1	–	Voltage test
2	–	–	2	Intrinsic error
	2	4.2	2.1	Ammeters and voltmeters
	3	4.2	2.2	Wattmeters and varmeters
	4	4.2	2.3 and 2.4	Frequency meters pointer type and vibrating reed
	5	4.2	2.5, 2.6, 2.7	Phase meters and power factor and synchroscopes
	6	4.2	2.8	Ohms meters
	8	4.2	2.9 and 2.10	Shunts and resistors
3	–	–	3	Variation tests
	1 to 8	6.2.3	3.1.1 and 2	Variation due to ferromagnetic support fixed and portable
	1	Table 2	3.2	Variation due to ambient temperature
	1 to 8	Table 2	3.3	Variation due to humidity
	1	Table 2	3.4.1 and 2	Variation due to position (with symbol and without marking)
	1	Table 2	3.5	Variation due to magnetic field of external origin
	1 to 8	Table 2	3.6	Variation due to ripple on d.c. measured quantity
	1 to 8	Table 2	3.7	Variation due to distortion of a.c. measured quantity
	1 to 8	Table 2	3.8	Variation due to frequency of a.c. measured quantity
	2	Table 2 of IS 1248 (Part 2)	3.8.1	Ammeters and voltmeters
	3	Table 2 of IS 1248 (Part 2)	3.8.1	Wattmeters and varmeters
	5	Table 2 of IS 1248 (Part 5)	3.8.2	Phase meters
	5	Table 2 of IS 1248 (Part 5)	3.8.3	Power factor meters
	5	Table 2 of IS 1248 (Part 5)	3.8.4	Synchroscopes

ANNEX A (*Continued*)

Sl No.	*Clause Reference of Individual Specification*		*Test Method (see Part 9, Clause)*	*Type Test*
	Part(s)	Sub-clause	Sub-clause	
	8	Table 2 of IS 1248 (Part 8)	3.8.5	Accessories
	–	–	3.9	Variation due to voltage/current component of the a.c. measured quantity
	3	Table 2 of IS 1248 (Part 3)	3.9.1	Wattmeters and varmeters
	4	Table 2 of IS 1248 (Part 4)	3.9.2	Frequency meters
	5	Table 2 of IS 1248 (Part 5)	3.9.3	Phase meters
	5	Table 2 of IS 1248 (Part 5)	3.9.4	Power factor meters
	5	Table 2 of IS 1248 (Part 5)	3.9.5	Synchroscopes
	–	–	3.10	Variation due to power factor
	3	Table 2 of IS 1248 (Part 3)	3.10.1	Wattmeters
	3	Table 2 of IS 1248 (Part 3)	3.10.2	Varmeters
	6	5.2.5	3.11	Variation due to battery voltage
	3	Table 2 of IS 1248 (Part 3)	3.12	Variation due to unbalanced current
	1	6.2.4	3.13	Variation due to conductive supports
	1	6.2.2	3.14	Variation due to electric field of external origin
	–	–	3.15	Variation due to simultaneous influence to voltage and power factor
	3	Table 2 of IS 1248 (Part 3)	3.16	Variation due to interaction between the different measuring elements of polyphase instruments
	1	Table 2	3.17	Variation due to auxilliary supply, voltage
	1	Table 2 of IS 1248 (Part 2)	3.18	Variation due to auxilliary supply, frequency

ANNEX A (*Concluded*)

Sl No	*Clause Reference of Individual Specification*		*Test Method (see Part 9, Clause)*	*Type Test*
	Part(s)	Sub-clause	Sub-clause	
4	1 to 8	7.5	4.1	Limiting values of temperature
5		7.2		Damping
	1 to 4	7.2.1	4.2	Overshoot
	1 to 8	7.2.2	4.3	Response Time
		7.2.3		Impedance of external measuring circuit
6		7.4		Permissible overloads
	1 to 5	7.4.2	4.4	Overloads of short duration on instrument
	8	6.4.2	4.5	Overload of short duration on accessories
	1 to 5	7.4.1	4.6	Overload continuous on instrument
	8	6.4.1	4.7	Overload continuous on accessories
	2 and 3	6.1.1	4.8	Current circuit continuity after high current
7	1 to 5	7.6	4.9	Deviation from zero
8	1	8.5	4.10	Effect of vibration and shock
	5	6.7.2	4.11	Drop-out different frequency for synchroscope
	5	6.7.3	4.12	Pull-in different frequency for synchroscope
	5	6.7.4	4.13	Open circuit for synchroscope
9	1 to 8	7.3	4.14	Self-heating
	6	8.1.1	4.15	Ohm meter maximum current
	3	6.6.2	4.16	Voltage circuits only energized for Wattmeter and Varmeter
	–	–	4.17	Tracking error
	1	8.4	4.18	Range of mechanical zero adjustment
	–	–	1.2.6 and 1.2.7	Zero adjustment mechanical and electrical
	1	10.1.3	4.19	Performance of marking for terminals and connection diagrams

ANNEX B

(*Clause* 6)

PERMISSIBLE ERRORS AND VARIATIONS

B-1 When an instrument or an accessory is operated under reference conditions, it is permitted to have an error (the intrinsic error) no grater than is implied by its class index, for example, for a class 0.5 instrument, the errors are not permitted to exceed 0.5 percent of the fiducial value.

B-2 However, when an instrument or an accessory is operated outside its reference conditions for a particular influence quantity (but under reference conditions for all the other influence quantities), it is permitted to have a change in its error, called a variation, when that influence quantity is changed up to the limit of its nominal range of use. The value of the permissible variation is expressed as a percentage (usually 100 percent) of the permissible intrinsic error.

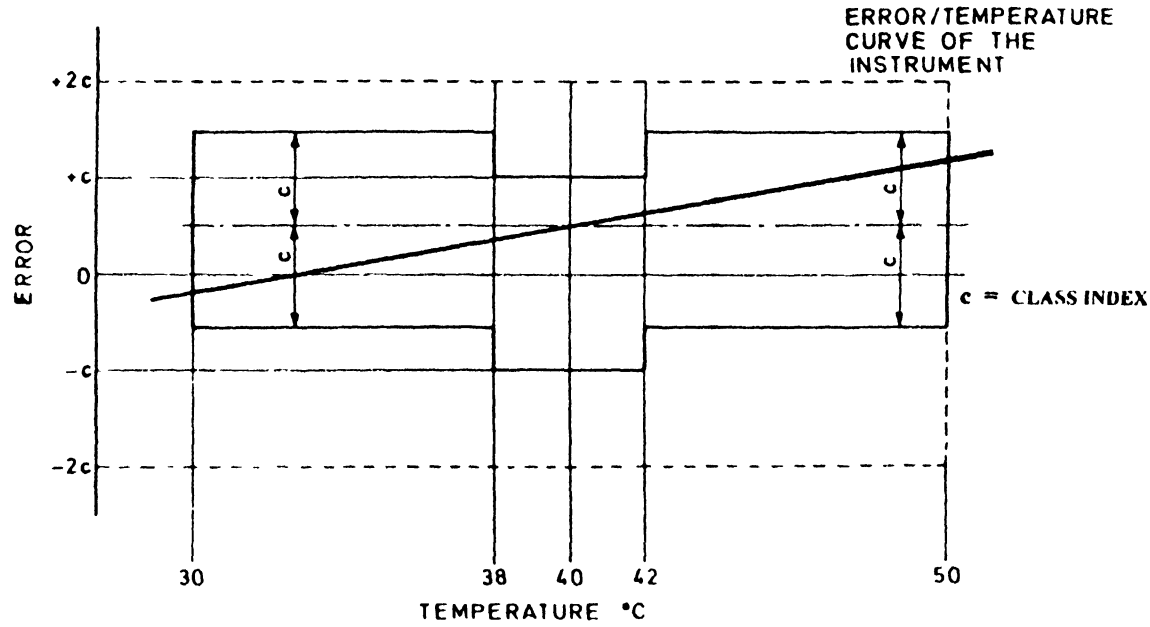
B-3 The same value of variation is permitted over the whole of the nominal range of use up to both of its limits, but the sign need not be the same.

B-4 For example, an instrument having a class index of 0.5 and a reference temperature of 40°C, marked as 40°C in accordance with **9.3.1**, is permitted to have an intrinsic error of ± 100 percent of the class index, at the reference temperature and over the testing tolerance of ± 2°C (*see* Table 1), around 40°C.

B-5 In addition, over the nominal range of use for temperature of 30°C to 50°C (40°C ± 10°C : *see* Table 2), this instrument is permitted to have a variation of ± 100 percent of the class index around the value of the error which it had at the reference temperature (40°C). It is thus possible for the instrument to have a smaller error at some temperature within the nominal range of use than it had at the reference temperature.

B-6 Figure 4 shows how the error of this instrument is permitted to alter with temperature, the class index being shown as *c*.

B-7 If the error at the reference temperature (the intrinsic error) had been at its maximum permitted value of + *c*, the total permitted error over the temperature ranges 30°C to 38°C and 42°C to 50°C would have been between zero and +2*c*. Similarly, if the intrinsic error had been –*c*, the total permitted error would have been from zero to –2*c*.



Reference value 40°C
Nominal range of use (Table 2) : 30°C to 50°C.

FIG. 4 EFFECT OF TEMPERATURE

B-8 When the reference condition of a particular influence quantity is a reference range, over the parts of the nominal range of use which are outside the reference range, the permissible variation is centred on the value of the error at the adjacent limit of the reference range.

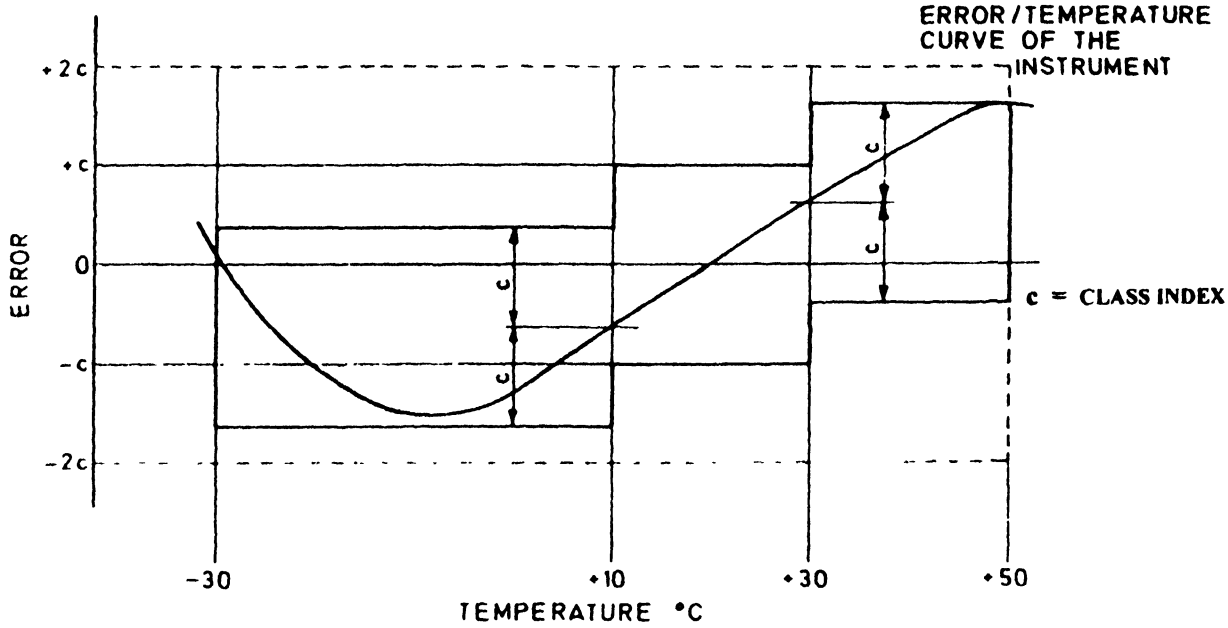
B-9 Figure 5 shows error/temperature curve of the instrument.

B-10 Figure 5 is an example of an instrument having a class index of 0.5 and marked –30 ... + 10 ... +30 ... +50°C in accordance with **9.3.3** (reference range for temperature +10°C to +30°C; nominal range of use for temperature –30°C to +50°C) is permitted to have an intrinsic error of ±100 percent of the class index over the temperature range +10°C to +30°C.

B-11 In addition, over the nominal range of use of – 30°C to + 10°C, a variation is permitted of ± 100 per cent of the class index centred on the error which the instrument had at +10°C. Similarly, a variation of ± 100 per cent of the class index, centred on the error which the instrument had at + 30°C is permitted over the nominal range use from + 30°C to + 50°C.

B-12 If, as is likely in practice, more than one influence quantity is simultaneously outside its reference condition, the resultant error is unlikely to exceed the sum of the separate variations and may be smaller than any of them, as the resulting errors may to some extent cancel each other.

B-13 Information about the simultaneous effect of several influence quantities can usually only be determined by carrying out tests for particular combinations of values of influence quantities. The manufacturer may sometimes be able to provide this information.



Reference range: +10°C to +30°C (different from Table 1).
Nominal range of use: -30°C to +50°C (different from Table 2).

FIG. 5 EFFECT OF TEMPERATURE

ANNEX C

(*Clause* 11.2.1)

INFORMATION ON GENERAL TEST CONDITIONS

Sl No.	*Clause Reference of Individual Specification*		*Test Method as Ref to Cl of IS 1248 (Part 9)*	*Test Conditions*
	Part(s)	Sub-clause	Sub-clause	
1	1 to 8	1 to 8	1.2.1	Reference conditions
2	–	–	1.2.2	Parallax
3		-	1.2.3	Tapping
4	1	6.3.2	1.2.4	Thermal stability
5	1	4.3.1	1.2.5	Pre-conditioning time
6	-	–	1.2.8	Test equipment errors
7	–	-	1.2.9	Reading methods
8	-	-	1.2.10	Polyphase methods
9	-	–	1.2.11	a.c. instruments testing on d.c.
10	–	–	1.2.12	Multirange and Multifunction instruments
11	–	–	1.2.13	Test leads
12	6	4.4	1.2.14	Ohm meter testing

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Amendments Issued Since Publication

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